GENETIC dilemmas

# GM plant dilemmas

## Background information

### Genetic modification

Genetic modification (GM) has been in use commercially since 1996. GM crops are described by many different names - genetically modified organisms (GMOs), genetically engineered (GE), “transgenic” or “biotech” crops. GMO is the official term used in the EU. In general, these all refer to a plant carrying DNA from another organism.

Genetic- engineering has been used in different ways. In medicine, it has been used to produce artificial insulin, drugs and vaccines. More controversially, it is being used to produce new types of agricultural crops to feed animals and for human consumption.

In 2010, GM crops were commercially grown in 29 countries, including 8 in the EU, 5 in Asia and 3 in Africa, amounting to approximately 10% of global crop land. The majority were the four crops: maize, soybean, cotton and oilseed rape but many more are in development.

This website gives a very comprehensive overview:

http://www.gmo-compass.org/eng/home/

### New potatoes

Potato Blight is caused by a fungus *Phytophthora infestans*. It spreads through the air and develops when the weather conditions are warm and humid. There was a terrible famine in Ireland between 1845 and 1849, sometimes known as The Irish Potato Famine. Potatoes were the staple food in Ireland and, at the time the potato blight struck, the Irish grew a very limited number of varieties of potatoes. If they had grown more varieties some may have been resistant to the blight and the famine’s effects could have been lessened.

From: http://www.guardian.co.uk/science/2013/apr/02/gm-potato-blight-ireland-famine

*Ewen Mullins is the face of modern Ireland: young, cosmopolitan, highly educated, he is a plant scientist whose work on a genetically modified potato inherently looks to the future. But Mullins must also think back to one of Ireland’s darkest chapters, the Great Famine of the 1840s. “It’s always there,” he said. “It’s not something we forget or something we should be allowed to forget. ”From his laboratory and greenhouse at a research farm outside Carlow, 42-year-old Mullins deals daily with a disease that not just afflicts his native land, but haunts it: the potato blight, a pernicious rot caused by a fungus that still thrives in Ireland’s wet, cold climate. The disease has become even more damaging in the past five years with the arrival of new, highly aggressive strains. Unchecked, blight can destroy entire crops in days. Mullins and his team have spent the winter cloning new potato stock in a locked temperature control room and, nearby, a secured greenhouse bay where the plant is isolated and any waste must be sterilised in a steamer.*

*Soon they will start the test by setting out more than 2,000 transplants in a fenced field at the Irish agricultural research service's farm. "There's a lot of public interest" in his work, said Mullins. Not all of it is friendly. Genetic engineering remains highly controversial in Europe and the research in Ireland has spawned a campaign against it. The field trials in Carlow are harming Ireland's reputation for local, organic and artisan food, said Kaethe Burt-O'Dea, a Dublin based local-food activist. "People feel that once you let GM in, there's really no turning back," she said. But proponents of the GM potato say its eventual use could prevent harmful and expensive applications of pesticides and bolster potato yields, which are decimated by the blight in poorer countries today.*

The potato is the third most consumed crop on the planet after wheat and rice, and has become increasingly important in the developing world, which now has more potato fields than developed countries. Today Irish farms are mainly pasture land and cereal production but the potato remains an iconic vegetable there, in many homes arriving nightly on the dinner table.

## Turbocharged rice

Green plants all photosynthesise but the biochemical pathways which they use are not all the same. Rice uses a $C_3$ photosynthetic pathway which, in some ways, is less efficient than the $C_4$ pathway used by plants such as maize. In all plants $CO_2$ is fixed by the enzyme Rubisco. It catalyses the carboxylation of ribulose-1,5-bisphosphate (RuBP) to form two molecules of glyceraldehyde-3-phosphate (G3P).

Scientists think that $C_3$ plants evolved at a time when the planet had a very high concentration of $CO_2$. In these conditions Rubisco operated at its optimum and $CO_2$ concentration was not a limiting factor. In the current atmospheric $CO_2$ concentration the efficiency of Rubisco, and therefore photosynthesis, in $C_3$ plants, can be decreased by 40%. In $C_4$ plants there are several biochemical and structural changes which allow plants, with this photosynthetic pathway, to concentrate $CO_2$ at the site of Rubisco. So in $C_4$ plants Rubisco operates at its optimum under these high $CO_2$ concentrations and as a consequence $C_4$ plants need less Rubisco. This leads to more efficient use of nitrogen (needed to produce Rubisco and other plant proteins) in $C_4$ compared to $C_3$ plants. In addition, $C_4$ plants can get enough $CO_2$ even when their stomata are not fully open, so water loss by transpiration is reduced.

The IRRI (International Rice Research Institute) has begun a project to genetically modify rice - the $C_4$ rice project, or "turbo-charged rice". The project, which brings together a mix of international partners, is attempting to make rice much better at photosynthesis by converting it from the $C_3$ photosynthetic pathway to the $C_4$ pathway. Rice already has all the components required for $C_4$ photosynthesis, but they are distributed differently within rice cells. By rearranging the photosynthetic structures within the leaves using genetic modification, it is theoretically possible to switch rice over to $C_4$ photosynthesis - potentially increasing productivity by 50%.

In 2012, the $C_4$ rice project got an injection of financial support valued at US $14 million over 3 years from the Bill and Melinda Foundation and the UK government. *"This is exactly the sort of innovative scientific research that the [UK] Prime Minister was calling for at the Hunger Summit at Downing Street," said Lynne Featherstone, UK Parliamentary undersecretary of state for international development. "This new funding will enable IRRI to begin producing prototypes of this 'super rice' for testing. This could prove a critical breakthrough in feeding an ever-growing number of hungry mouths."*

From: http://irri.org/index.php?option=com _ k2&view=item&id=12438#Turbo

The research still has a long way to go, but the scientists have already identified crucial genes needed to assemble $C_4$ photosynthesis pathways in rice, and they now aim to produce $C_4$ rice prototypes for testing.

***Rubisco, is the most abundant enzyme on Earth - and arguably one of the most important for life!***